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Scientific Note

Occurrences of Diptera on Tree-Trunk Mosses in a Costa Rican Tropical Rain Forest

This brief communique summarizes the occurrence of Diptera on epiphytic mosses on two closely-spaced trees (*Pentaclethra macroloba* [Willd.] Ktze.-Leguminosae) in a Costa Rican tropical rain forest.

The study site is "Finca La Tigra," near La Virgen (10°23′N, 84°07′W, 220 m elev.), Sarapiqui District of the Heredia Province, Costa Rica.

The locality is characterized by sporadic, brief periods of dryness (Fig. 1). The study site is a mixed primary and secondary-growth forest bordering a cacao plantation. The two *P. macroloba* trees chosen for censusing dipterans on mosses (Diameter Breast Heights are 15.0 cm and 40.0 cm for Trees Nos. 1 and 2, respectively) are within a few meters of one another in dense shade. *Pentaclethra macroloba* is relatively common in this forest, as it is throughout much of the lowland-to-premontane rain forest region from Nicaragua to the Guianas (Whitmore, J. L., and G. S. Hartshorn, 1969, Literature review of common tropical trees, Contrib. No. 8, Inst. Forest Products, Univ. Washington, 113 pp.).

Between 2 December 1982 and 10 November 1983, I collected adult dipterans perched on patches of moss on these two trees (Fig. 2), between 0630–0900 hr and 1200–1300 hr, for each of four census dates. Diptera were collected, using dry glass vials, from ground level to about 1.5 m on each tree trunk. I rotated visits to each tree trunk at about 15-minute intervals. Between 10–20% of total dipterans seen during one morning or afternoon census period escaped capture. Dipterans were later sorted, preserved in 70% ethanol, and taxonomic determi-

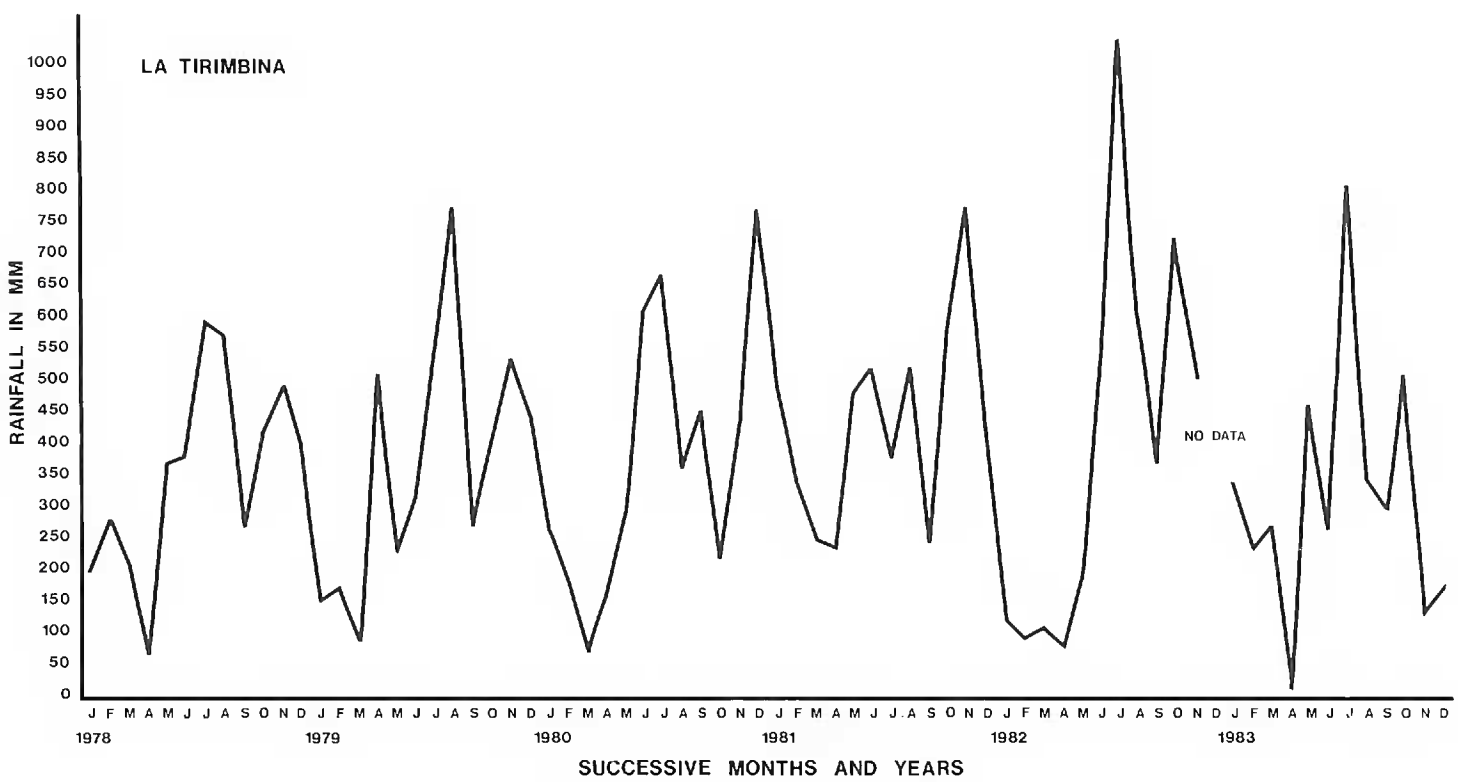

Figure 1. The monthly pattern of rainfall at "Finca La Tirimbina" over several successive years, and showing the 50–100 mm monthly totals associated with the "*veranillo*" typical of this tropical rain forest locality in Costa Rica.

Figure 2. Left: mosses on the trunk of Tree No. 1; Right: tropical rain forest understory habitat in the vicinity of the study site at "Finca La Tigra."

nations made with the cooperation of the Systematic Entomology Laboratory of the U.S. National Museum. A small sample of moss from each tree was taken for determinations.

Two species of moss were found on both tree trunks (Fig. 2): *Syrrhopodon incompletus* var. *berteranus* (Brid.) Reese (abundant); *S. erubescens* Bartr. (very rare).

For all four censuses combined, a total of nine species of Ceratopogonidae, the most frequently-encountered dipteran family, were collected, principally on Tree No. 2 (Table 1). Cecidomyiidae were far less numerous (Table 2). The sex ratios of these dipterans (both families) approached 1:1 (Tables 1 and 2). For the Ceratopogonidae, the genus *Atrichopogon* was represented by the highest number of species, followed by *Forcipomyia* (Table 1). The most abundant ceratopogonid species, *Atrichopogon* sp. 2, comprised 53.2% of the entire sample (all dates combined), followed by *A.*, n. sp. nr. *minuta* (Meigen) (13.8%) (Table 1). The sex ratio for *Atrichopogon* sp. 2 was 19 females: 31 males, or almost 1:2 skewed towards males. For *A.*, n. sp. nr. *minuta,* this bias towards males was even more pronounced: 1 female : 12 males. The genus *Atrichopogon* alone accounted for 86.8% of the total numbers of ceratopogonids collected from Tree No. 1, and was almost equally distributed between *A.* sp. 2 and *A.*, n. sp. nr. *minuta.* The same genus accounted for 78.6% of all ceratopogonids collected from Tree No. 2, but with *A.* sp. 2 accounting for 69.8% of the genus. While the genus *Forcipomyia* was diverse in terms of numbers of species collected, total numbers of individuals accounted for only 17.8% of all dipterans collected from both trees. The cecidomyiid genus *Clinodiplosis* accounted for 44.4% of all cecidomyiids collected on

Table 1. Distribution and taxonomic "diversity" of adult midges (Diptera: Ceratopogonidae) on two moss-covered tree trunks in the tropical rain forest at "Finca La Tigra," near La Virgen, Sarapiqui District, in northeastern Costa Rica.*

"Tree No. 1"		"Tree No. 2"	
Species	Individuals	Species	Individuals
Dasyhelea soriai Wirth & Waugh	3	*D. soriai* Wirth & Waugh	2
Forcipomyia genualis (Loew)	1	*F. genualis* (Loew)	2
		F. fuliginosa (Meigen)	1
		F. (*Lasiohelea*), n. sp. 1	2
		F. (*Calaforcipomyia*) *caerulea* Macfie	2
		F. harpegonata Wirth & Soria	3
Atrichopogon, n. sp. nr. *minuta* (Meigen)	1	*A.*, n. sp. nr. *minuta* (Meigen)	2
A. sp. 1	1	*A.* sp. 1	3
A. sp. 2	11	*A.* sp. 2	39
A. sp. 3	2		
A. sp. 4	7		
A. glaber (Meigen)	1		
Culicoides, n. sp. nr. *metagonatus* Wirth & Bystrak	1		
Total genera: 4		Total genera: 3	
Total species: 9		Total species: 9	
Total individuals: 38		Total individuals: 56	
Total sample sex ratio (both trees): 36 females + 58 males			

* Data presented for a total of four census dates (2 December 1982, 3 March 1983, 8 August 1983, and 10 November 1983), and for two collecting periods each date (0630–0900 hr and 1200–1300 hr). See "methods" for other details.

Tree No. 1 and 55.6% on Tree No. 2. Most Cecidomyiidae were found to be "rare" in that they were represented by 1–2 individuals for all samples combined.

Both the greatest numbers of individuals and species of Ceratopogonidae were found in the late rainy season census (2 December 1982), and for Cecidomyiidae in the mid-rainy season (8 August 1983) at "La Tigra" (Table 3). There was a conspicuous absence of ceratopogonids on the mosses during the dry season (3 March 1983) (Table 3). For all Diptera collected, similar numbers of species and individuals were found in the morning and afternoon samples for all census dates combined (Table 4). For all other Diptera present, the following distributions of numbers of individuals per family were observed, considering all four census dates and times of the day: Drosophilidae (*Drosophila* spp.): 10; Psychodidae (*Psychoda* sp.): 4; Phoridae (*Megaselia* sp.): 2; Sciaridae (*Bradysia* sp.): 1; Mycetophilidae: 1; Chironomidae: 1; Chloropidae: 1. Interestingly, these families of Diptera were found on the mosses for only two rainy season censuses (December 1982 and August 1983).

Any conclusions drawn from the above data must be considered as tentative owing to (1) the small sample sizes of insects collected, and (2) the low number of censuses. Yet such data suggest the need to explore the effects of tropical seasonality on rain forest-inhabiting Diptera in some detail, since these organisms might serve as insightful indicators of the subtle ways in which changes in rainfall

Table 2. Distribution and taxonomic "diversity" of adult midges (Diptera: Cecidomyiidae) on two moss-covered tree trunks in the tropical rain forest at "Finca La Tigra," near La Virgen, Sarapiqui District, in northeastern Costa Rica.*

"Tree No. 1"		"Tree No. 2"	
Species	Individuals	Species	Individuals
Clinodiplosis sp. A	4	*Clinodiplosis* sp. A	5
Clinodiplosis sp. C	1		
Mycodiplosis, n. sp.	2	*Mycodiplosis,* n. sp.	3
Youngomyia, n. sp.	1		
Kalodiplosis sp.	1		
		Contarinia sp.	1
		Total genera: 3	
Total genera: 4		Total species: 3	
Total species: 5		Total individuals: 9	
Total individuals: 9			
Total sample sex ratio (both trees): 11 females + 7 males			

* Data presented for a total of four census dates (see footnote in Table 1).

(Fig. 1) influence insect activity. Traditionally, studies of insect seasonality in the American tropics have largely ignored small-bodied dipterans (e.g., Janzen, D. H., and T. W. Schoener, 1968, Ecology, 49:96–110). A notable exception is a populational study of phlebotomine sand flies in Colombia (Porter, C. H., and G. R. DeFoliart, 1981, Arquivos de Zoologia, Mus. de Zool., Univ. de São Paulo, 30:81–158). Other studies indicate that some Diptera in general are restricted in their daily and seasonal activity cycles largely through direct or indirect effects of moisture in forest habitats (e.g., Vanhara, J., 1981, Acta Scient. Nat. Acad. Sci. Bohemoslov. Brno., 15:1–32; Willmer, P. G., 1982, Ecol. Ent., 7:221–231). Many species of Ceratopogonidae breed in moss and other similar substrates in the American tropics (e.g., Soria, S. de J. et al., 1981, Rev. Theobroma [Brasil], 11: 119–123), and such substrates may undergo notable changes in moisture content as a result of phenological patterns of rainfall. During the Costa Rican dry season,

Table 3. Summary of the distribution of midge species (Diptera: Ceratopogonidae and Cecidomyiidae) by census dates.*

	Ceratopogonidae			Cecidomyiidae		
Census date	Total genera	Total species	Total individuals	Total genera	Total species	Total individuals
2 Dec. 1982	4	11	73	1	1	3
3 Mar. 1983	0	0	0	2	2	2
8 Aug. 1983	2	5	18	3	3	10
10 Nov. 1983	1	1	3	2	2	3
Highest midge "biomass":	73/94 = 77.6% (late rainy season—Dec. 1982)			10/18 = 55.5% (mid-rainy season—Aug. 1983)		
Lowest midge "biomass":	0/94 = 00.0% (dry season—March 1983)			2/18 = 11.1% (dry season—March 1983)		
Highest midge species number:	11 (late rainy)			10 (mid-rainy)		

* See headings and footnotes of Tables 1 and 2 for details of census dates, etc.

Table 4. Difference in abundance and taxonomic "diversity" of midges (Diptera) on moss-covered trunks of two tropical rain forest trees (both *Pentaclethra macroloba*-Leguminosae) at "Finca La Tigra," near La Virgen, Sarapiqui District, in northeastern Costa Rica for morning versus afternoon activity periods.*

Species	0800–0900 hr No. of individuals	1200–1300 hr No. of individuals
Atrichopogon, n. sp. nr. *minuta* (Meigen) (Ceratopogonidae)	5	7
Atrichopogon sp. 1	1	1
Atrichopogon sp. 2	1	0
Forcipomyia genualis (Loew)	1	0
F. harpegonata Wirth & Soria	2	1
F. fuliginosa (Meigen)	0	1
F. (*Lasiohelea*), n. sp. 1	0	2
Clinodiplosis sp. A (Cecidomyiidae)	3	5
Clinodiplosis sp. C	0	4
Contarinia sp.	0	1
Megaselia sp. (Phoridae)	4	0
Mycomya sp. (Mycetophilidae)	1	0
Drosophila sp. (Drosophilidae)	3	3
Bradysia sp. (Sciaridae)	0	1
Psychoda sp. (Psychodidae)	0	1
Total morning species: 9	Total afternoon species: 11	
Total morning individuals: 21	Total afternoon individuals: 27	
Total distinct species for entire sample (morning & afternoon) combined: 13		
% of species accountable by morning census: 9/13 = 69.2%; by afternoon: 11/13 = 85.4%		
% of individuals ("biomass") accountable by morning census: 21/48 = 43.8%		
% of individuals ("biomass") accountable by morning census: 27/48 = 56.2%		

* One morning and one afternoon census taken on 8 August 1983 form the basis of the above comparisons.

for example, there is a sharp decline in the abundance of Ceratopogonidae and even other insects in leaf-litter and other ground-cover substrates at this time of the year (e.g., Young, A. M., 1983, J. Appl. Ecol., 20:801–831).

It is likely that some of the observed Diptera actually breed in the mosses. The occurrence of several species of *Atrichopogon* and *Forcipomyia* appears typical for these groups as seen for other organic substrates in Costa Rican rain forest areas (e.g., Young, A. M., 1982, J. Appl. Ecol., 19:47–63; 1983, J. Appl. Ecol., 20:801–831; 1984, Proc. Ent. Soc. Wash., 86:185–194). The observed low abundance of Cecidomyiidae, relative to the Ceratopogonidae, may be the result of these insects having specialized life cycles, often associated with fungi and rusts in the case of genera such as *Mycodiplosis* and *Clinodiplosis* (e.g., Gagne, R. J., 1977, Brenesia [Costa Rica], 12/13:113–131; R. J. Gagne, pers. comm.). The larvae of other cecidomyiids, such as the genus *Contarinia,* feed on living plant tissues, while those of *Youngomyia* are predators on other insects (R. J. Gagne, pers. comm.). Other cecidomyiids in Costa Rica do breed in moss (Young, A. M., 1985, Proc. Ent. Soc. Wash., 87:49–79).

These mosses also harbor decaying organic matter, providing additional breeding or feeding substrates for tropical rain forest Diptera. What my limited data do show is that there is a consistent pattern of "association" of several families

of Diptera, with representative species known to be associated with mosses and accompanying organic debris as breeding substrates in the tropical rain forest.

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